UNITED STATES PATENT OFFICE.

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FILAMENT FOR INCANDESCENT LAMPS.

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To all whom it may concern:

Be it known that I, ERWIN F. VON WILMOWSKY, a citizen of the United States, residing at the city of Boston, Commonwealth of Massachusetts, have invented a new and useful article of manufacture—to wit, a new electrical conductor for use in incandescent electric lighting, and also means or methods of producing the same, of which the following is a specification.

The objects of my invention are to produce an electrical conductor for use in incandescent electric lighting which shall consist in whole or mainly, but not necessarily entirely, of a material of very high infusibility and resultant electric-current-carrying and light-radiating capacity, and likewise to devise suitable means and methods of producing said material and for its incorporation into a practical incandescent conductor. The infusibility of said material is quite beyond the temperature at which the most refractory metals melt.

I attain the objects of my invention by constructing my electrical conductor in whole or mainly, but not necessarily entirely, (since, for instance, some other material, such as carbon, may form a core and be incidentally part of the filament, as hereinafter more fully referred to,) of boron and applying it for use, preparing the boron, and incorporating it into such electrical conductor as follows: Boron has hitherto been known only in the form of a powder and not in any such form as admitted of its application and use for the purpose of electric incandescent lighting. I have invented an electrical conductor composed substantially of boron brought into form and condition available for the purposes of conductors for electric incandescent lighting by means of treatment which I have invented and which I will hereinafter describe.

Broadly considered, my invention therefore consists in the construction of an electrical conductor for incandescent lighting substantially composed of boron and in the production of a method of treating this hitherto unavailable substance in such manner as to enable it to be used for the purpose desired.

My boron electrical conductor may be preferably constructed as follows: I first prepare a solid compound of magnesium and boron by subjecting amorphous boron or the compounds of boron to the action of metallic magnesium at the high temperature of, say, a yellow heat, in an atmosphere of hydrogen or other equivalent gas, preferably under higher than normal atmospheric pressure, and in the proportion of, say, one part of preferably amorphous boron to three and one-half parts of magnesium. The resulting mixture or compound, containing mainly magnesium and boron, is a solid which should be stored for use in well-stoppered vessels until required in a subsequent step of the process, as hereinafter described. From this compound or mixture of boron and magnesium, and possibly hydrogen, I produce a gas by decomposing it by means of any convenient acid—such, for instance, as muriatic or acetic acid or the like—and taking care to avoid any oxidizing acid—such, for instance, as nitric acid. In practice the gas desired may be produced by depositing the solid compound, broken into convenient pieces, in a glass vessel or retort from which atmospheric air has been completely displaced by a gas, such as hydrogen. The acid may then be applied in any convenient manner and in proportion to the supply of gas which it is desired shall be produced. It is also prudent to apply to the exterior of the glass vessel any of the well-known cooling appliances. The magnesium of the above solid compound combines with the acid and remains behind, together with the greater part of the boron, while a gas mixture containing, essentially, hydrogen and a boron compound is developed. Said boron compound is characterized by its quality of becoming decomposed when brought into contact with hot surfaces—for instance, those of a carbon filament at or above red heat—in which case the boron will be deposited upon such surfaces in an elementary condition and in more or less dense form, so as to adhere. The gas resulting from the decomposition of the solid compound or mixture, containing mainly boron and magnesium, as aforesaid, and which I will hereinafter term "boron gas," should be washed with water and be dried—for instance, by sulfuric acid—in the well-known manner.

It is then ready for application, as hereinafter described. I also prepare by inclosing in a convenient chamber or vessel a core in an electric circuit, said core having the form or arrangement which is desired in the electrical conductor to be constructed. Such core may consist of a very thin iron wire or, preferably, a thin electrical conductor of carbon. The atmosphere is carefully removed from the interior of the chamber or vessel containing this electrical conducting-core and hydrogen or its equivalent substituted therefor. The gasometer or other vessel containing the dry gas derived from the compound or mixture of magnesium and boron is then connected with the interior of the chamber or vessel containing the aforesaid core, and said gas admitted and preferably carried through in a continuous stream under sufficient pressure to expel the hydrogen or its equivalent through a tube dipping into sulfuric acid, whereby the said gas containing the boron is caused to surround the said core. The electric current is now passed through the said core, so as to heat the same at or above red heat and thereby decompose the boron gas and to deposit boron upon the surface of the heated core, care being taken to keep the temperature of the growing electrical conductor as constant as possible by regulating the current. Under the conditions described the boron in the said gas will be evenly deposited upon all sides of the said core, and the thickness of the deposit will depend upon the length of the exposure. The exposure may be continued until the deposited boron shall constitute altogether the major portion of the resulting electrical conductor, the core being comparatively so small and insignificant as to be substantially disregarded, not only as regards relative bulk, but also electrical function. In the application of the process as described care should be taken to exclude silicon in every form at all stages of the procedure, since the presence of silicon or its compounds in even the slightest amount in the incandescent conductor is likely to discolor the glass bulb into which the electrical conductor as finally constructed is to be mounted for use in the usual way.

The thickness of the deposit of the boron upon the core should be such as to insure sufficient mass in the boron to enable it to resist the disturbances which may be caused by the contraction and expansion of the core, since the coefficient of expansion of the carbon or metallic core is different from that of the boron, and unless the deposit has been continued to an extent to insure independent strength in the mass of boron the latter is likely to be broken and to peel undesirably in consequence of changes of temperature in the core. It will be understood that the core plays substantially no function in the operation of the completed electrical conductor, its use being primarily and principally to afford only a nucleus or support upon which the deposit may be commenced. It is likewise of importance to the successful application of my process that too high temperature should be avoided during the deposit of the boron. A temperature should be found and adhered to with the greatest possible constancy during the deposition, which, while generally describable, as aforesaid, as at or above red heat, will not be so high as to result in the undue agglomeration of the depositing boron, whereby an undesirable tendency of the mass to crack and peel is developed, but should, on the contrary, be of such comparatively lower temperature as to insure a sufficiently loose contact between the particles of depositing boron, among themselves, and also between them and the carbon core to prevent slight possible variations in the temperature of the core from rupturing the mass of the deposit prior to the latter having gained sufficient bulk to be self-supporting and able to resist such variations. As the deposition progresses, however, the temperature should be raised successively to correspondingly increase the compactness and strength of the deposit then being added. It is of advantage to have comparatively loosely compacted those particles of boron in the immediate vicinity of the core to insure greater elasticity, and consequently diminished liability to fracture and peel, and to have all the rest of the boron more densely compacted, so as to increase the strength of the electrical conductor as a whole. The density of the deposit or the compactness of the particles of the boron in different portions of the electrical conductor—that is to say, the comparative looseness of the deposit at the interior or at its interior layers as compared with its comparative density at the exterior layers—will also depend upon the concentration of the boron gas—namely, the quantity of boron contained in the unit volume—and such relative density may be regulated accordingly during the progress of deposition—that is to say, the density of the boron deposited is inversely proportional to the rapidity of the deposition and the rapidity of the deposition is proportional to the concentration of the boron gas. Thus if at the commencement of the deposition the deposition-chamber be completely filled with the gas containing boron deposition will take place more rapidly and the particles of the deposit will be less tightly compacted together. As the deposition continues and the point is reached in which the comparative looseness of the particles ceases to be desirable, and greater compactness is of advantage, the concentration of the boron gas may be diminished by dilution with hydrogen or its equivalent, in consequence of which the speed of the deposition will be proportionately delayed and the compactness of the particles toward the exterior of the electrical conductor proportionately increased, with the resulting advantages which have already been described.

Though I have referred to metallic magnesium as utilized in the production of my boron gas, I do not wish to be understood as confining myself to that particular metal. It will of course be understood that similar easily-oxidizable metals might be employed, the boron compounds of which are readily decomposable by acids, producing gases, as aforesaid. The proportions of ingredients which I have mentioned will also doubtless somewhat vary, according to each particular case, without departing from my invention, since it is impossible to prescribe exact quantities and proportions for all conditions, and these should be studied and dealt with as experience in each case shall demonstrate.

The compound or mixture of magnesium and boron is preferably made by filling an iron crucible capable of withstanding pressure with solid pieces of magnesium metal embedded in the amorphous boron, and this in such a way that the charge is separated from the iron by a layer of anhydrous magnesia. Care, however, should be taken to heat all parts of the crucible uniformly and not to continue the heat too long after the reaction has taken place, else the compound will be decomposed by the magnesium volatilizing in the upper, because usually cooler, part of the crucible, while the boron remains in the lower part.

The boron deposited by my method, described as aforesaid, will be substantially pure, homogeneous, and adhesive.

What I claim as new, and desire to secure by Letters Patent, is the following, viz:

1. A filament or conductor for incandescent lighting composed substantially of boron.

2. An electrical conductor for use in incandescent electric lighting, composed of substantially pure, homogeneous and adhesive boron.

3. An electrical conductor for use in incandescent electric lighting consisting of a continuous body of pure homogeneous and adhesive boron, substantially as and for the purposes described.

4. An electrical conductor for use in incandescent electric lighting, consisting of a continuous annular deposit of substantially pure, homogeneous and adhesive boron around a central core of electrically-conducting material, substantially as and for the purposes described.

5. The method of making an incandescent filament or conductor composed substantially of boron, which consists in producing a compound or mixture mainly of magnesium and boron, or boron compounds, decomposing the same into a gas containing boron, and causing the deposition from the said gas of a conductor composed substantially of boron.

6. The method of making an incandescent filament or conductor composed substantially of boron, which consists in producing a compound or mixture mainly of magnesium and boron, or boron compounds, decomposing the same into a gas containing boron, and causing the deposition from the said gas of a conductor composed substantially of boron through the heating action of an electric current.

7. An electrical conductor for use in incandescent electric lighting, consisting of an annular continuous deposit of boron around a central electrically-conducting core, the particles of the boron being at or near such core less compacted than at or about the exterior of said conductor, substantially as and for the purposes described.

8. The method of producing an electrical conductor for use in incandescent electric lighting, composed of a continuous deposit of boron which consists in producing a solid compound or mixture mainly of magnesium and boron, decomposing the same into a gas containing boron, and heating by the electric current a core in the presence of said gas containing boron, substantially as and for the purposes described.

9. The process of producing an electrical conductor for use in incandescent electric lighting, consisting of a continuous deposit of boron, the particles of which are less compacted toward the interior and more compacted toward the exterior, which consists in preparing a compound or mixture mainly of magnesium and boron, decomposing the same into a gas containing boron, and heating in the presence of such gas a core, the said heating being at the outset of the operation at a lower temperature than at the close of such operation, substantially as and for the purposes described.

10. The process of constructing an electrical conductor for use in incandescent electric lighting, composed of a continuous deposit of boron, which consists in producing a solid compound mainly of boron, and magnesium, by subjecting said boron or its compounds and metallic magnesium to a high temperature in the presence of hydrogen, decomposing said compound by acid treatment into a gas containing boron, and heating a core in the presence of said last-mentioned gas by an electrical current, all substantially as and for the purposes described.

11. The process of constructing an electrical conductor for use in incandescent electric lighting, composed of a continuous deposit of boron, which consists in producing under pressure a solid compound mainly of boron and magnesium, by subjecting said boron or its compounds and metallic magnesium to a high temperature in the presence of hydrogen, decomposing said compound by acid treatment into a gas containing boron, and heating a core in the presence of said last-mentioned gas by an electrical current, all substantially as and for the purposes described.

12. The method of making an incandescent filament or conductor composed substantially of boron, which consists in producing a mixture or compound mainly of magnesium and

boron or boron compounds by heating the said materials in the presence of a non-oxidizing gas, then decomposing this compound product in the absence of the atmosphere by a non-oxidizing acid into a gas containing boron, and causing said gas to deposit a conductor of boron, or a compound containing boron, through the action of an electric current.

13. The method of making an incandescent filament or conductor composed substantially of boron, which consists in producing a mixture or compound mainly of magnesium and boron or boron compounds by highly heating the said materials in the presence of hydrogen, then in the absence of the atmosphere decomposing this compound product by muriatic or acetic acid, into a gas containing boron, and causing said gas to deposit a conductor of boron, or a compound containing boron, through the action of an electric current.

14. The process of constructing an electrical conductor, for use in incandescent electric lighting, composed of a continuous deposit of boron, which consists in producing a solid compound of boron and some suitable easily-oxidizable metal such as magnesium, by subjecting said boron or its compounds and such metal to a high temperature in the presence of hydrogen, decomposing said compound by acid treatment into a gas containing boron, and heating a core in the presence of said last-mentioned gas by an electrical current, all substantially as and for the purposes described.

15. The method of making an incandescent filament or conductor composed substantially of boron, which consists in producing a mixture or compound mainly of magnesium and boron or boron compounds by heating the said materials under pressure in the presence of a non-oxidizing gas, and then decomposing this compound product in the absence of the atmosphere by a non-oxidizing acid, into a gas containing boron, and causing said gas to deposit an adhesive conductor of boron or a compound containing boron through the action of an electric current.

16. The method of making an incandescent filament or conductor composed substantially of boron, which consists in producing a mixture or compound mainly of magnesium and boron or boron compounds by highly heating the said materials under pressure in the presence of hydrogen, then in the absence of the atmosphere decomposing this compound product by muriatic or acetic acid into a gas containing boron, and causing said gas to deposit an adhesive conductor of boron, or a compound containing boron, through the action of an electric current.

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Witnesses:

T. C. BYRNES,

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